

Gravity Implications of Qusier-Mersa Alam Offshore Area, Red Sea, Egypt

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ABSTRACT. The aim of the present study is to evaluate the sub-bottom geological setting of Qusier-Mersa Alam offshore area in relation to possible hydrocarbon entrapment. Marine gravity, as well as bathymetric data in addition to one seismic and two well logs have been used for this evaluation.

One subsurface geological map for shallow structures and two NE-SW geological models, are constructed to illustrate the tentative picture of the basement and its overlying sediments.

The results show a clysmic NW-SE major trend of faults dissect the continental and/or Oceanic Crust and form an alternation of grabens and horsts. A minor NE-SW trend of faults is also observed. The deep seated structures are framed out into a great monoclinial feature dipping westward with a rapid thinning of the continental crusts. This study points out the possibility of hydrocarbon resources occurrence within the wedges and truncations of the Post Miocene interfaces.

Introduction

Quseir-Mersa Alam offshore area lies on the northern part of the Red Sea (Fig. 1). It is confined between latitudes 25°N and 26°N and longitudes 34°E and 35°30'E. The bathymetric data show that the sea water depth, in the area, is between 100 m (at the west) and 1000 m (at the extreme eastern border).

Tectonically, the Red Sea development is a result of the relative motion of the Arabian-African plates (Darke and Girdler 1964; Lowell and Genik 1972).

Gravity Implications of Qusier-Mersa.

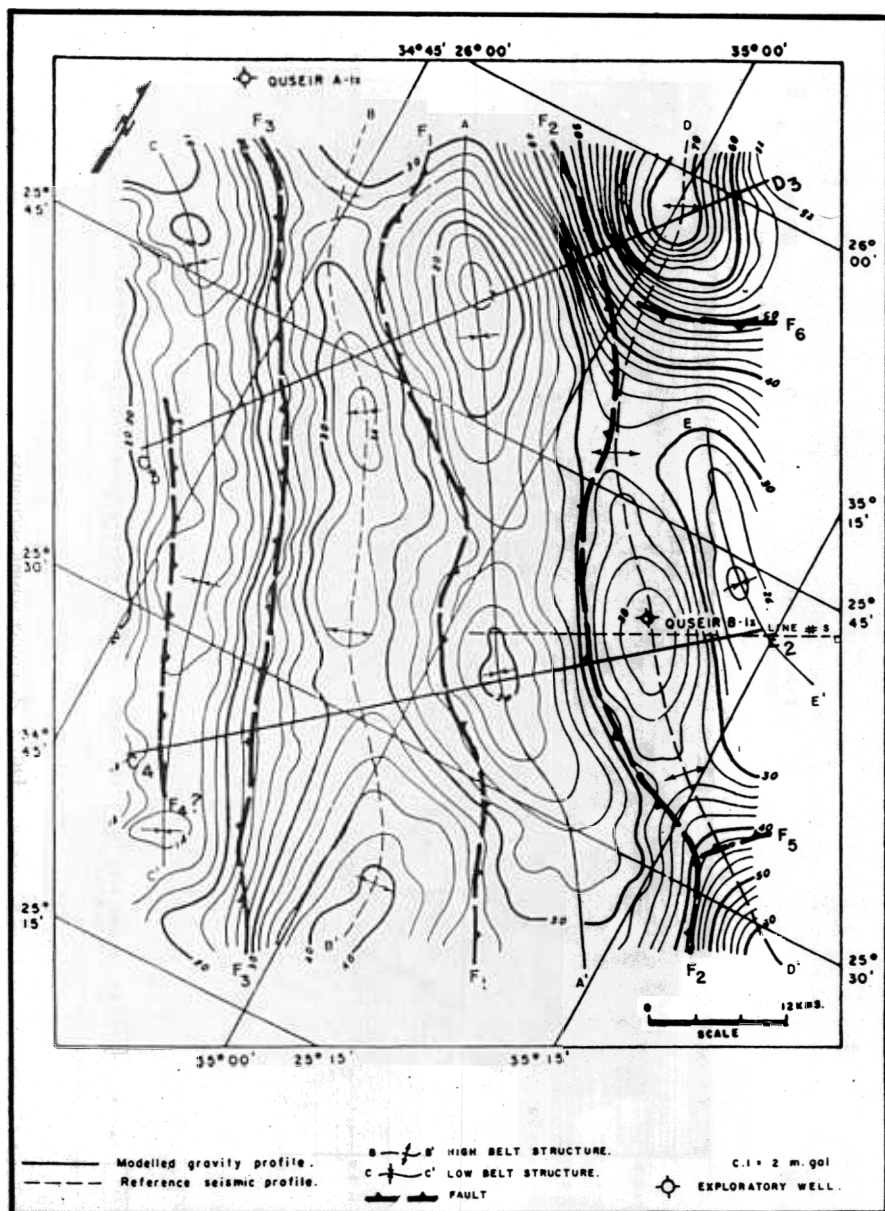


FIG. 2. Qualitative interpretation of Bouguer gravity map

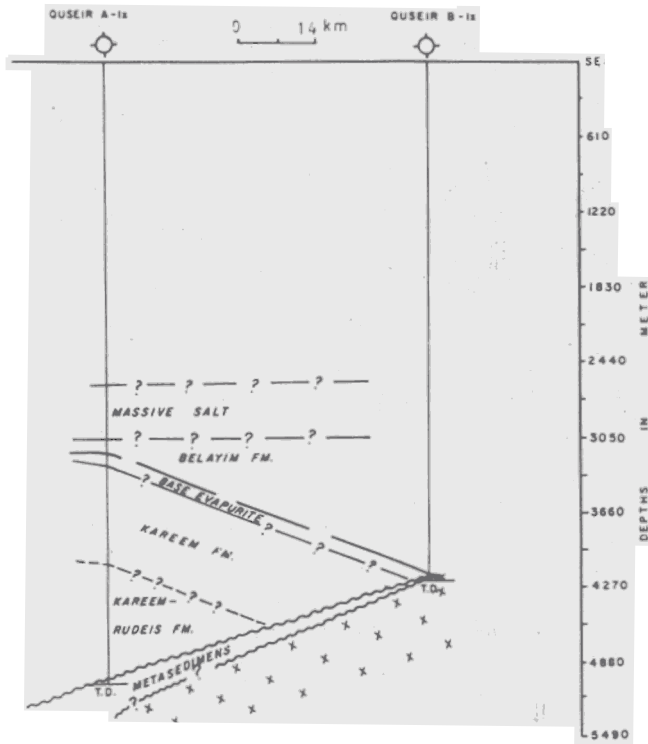


FIG. 4. Tentative picture of the subbottom geology along a profile between Quseir A-1X and B-1X exploratory wells.

Bouguer Data Analysis

About 1500 gravity data points, at the corners of 2 km side mesh squares, were picked from the Bouguer gravity map. The obtained data were subjected to different filter analysis techniques (for grid spacings: 2, 4, 6 and 8 kms). The application of least square technique for low order polynomial (Davis 1973) was tested and was found to be the best expression for the regional trend in the study area. The resulting regional and residual maps are shown in Fig. 5 and 6, respectively.

The second vertical derivative was calculated by using the Rosenbach's technique (1953). The resulted derivative anomaly map, for grid spacing 4 kms, is shown in Fig. 7. From the analysis of the previously obtained maps, a compiled shallow structural map (Fig. 8) was constructed.

Model Studies

The modelling technique is facilitated by using the computer program introduced by Talwani *et al.* (1964), developed by Nagy (1974) and modified by Ajakaiye and

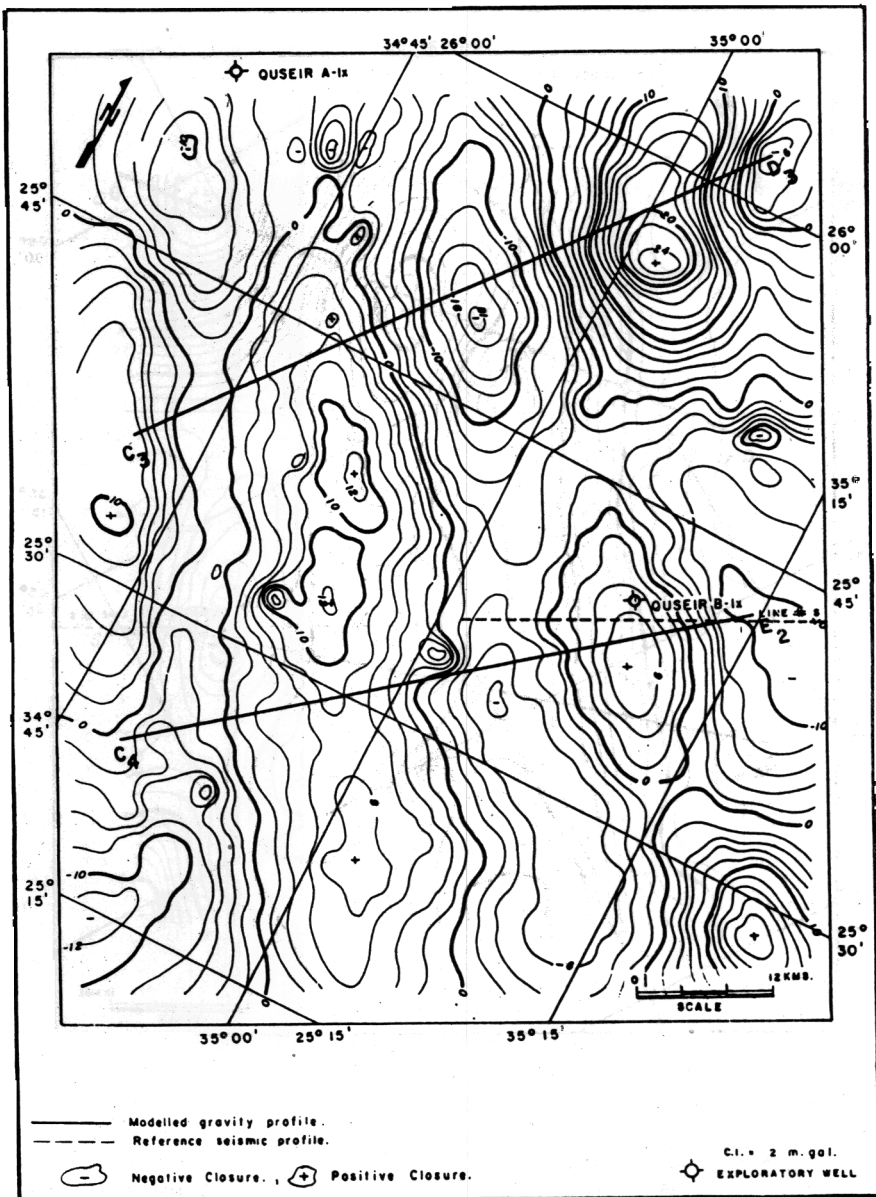


FIG. 6. Residual anomaly map by least squares filtering.

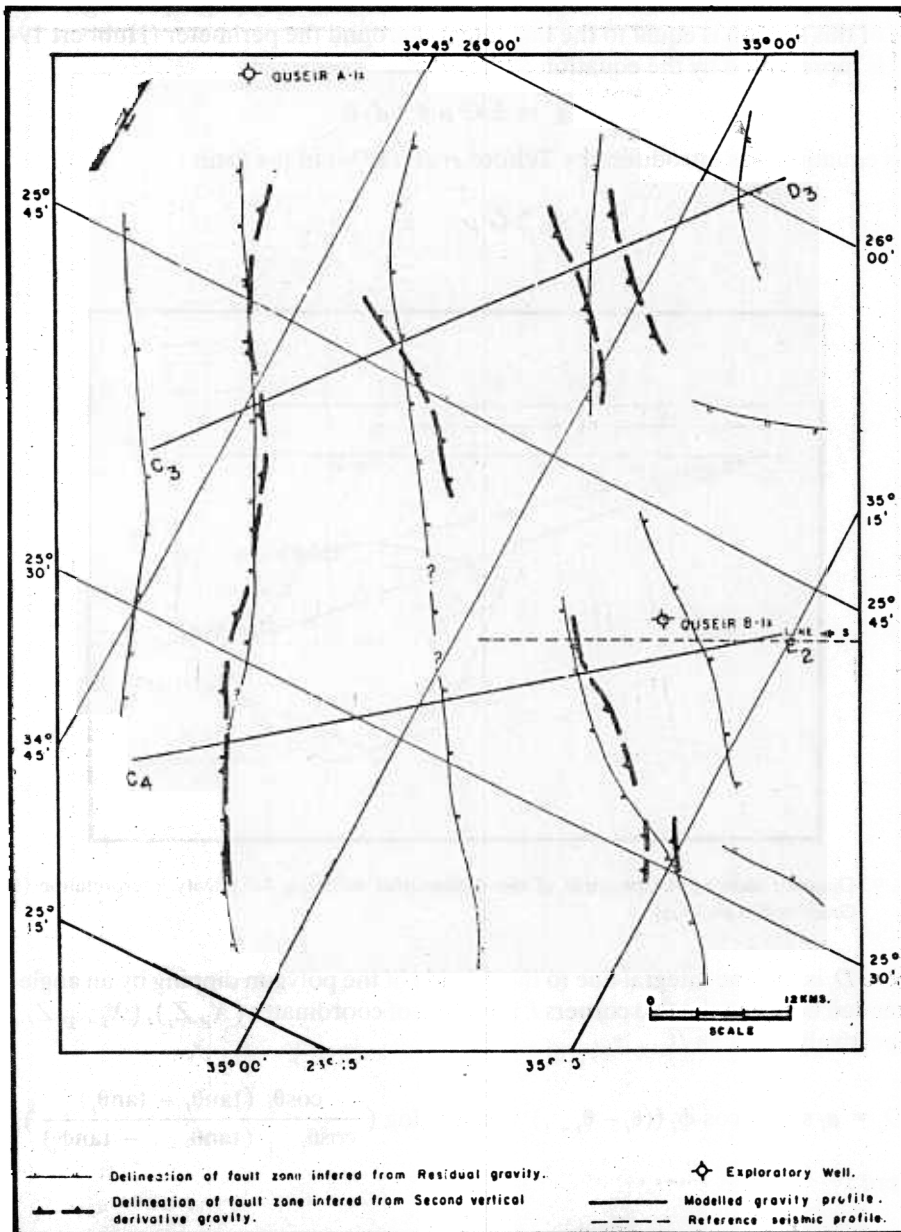


FIG. 8. Compiled shallow structural map revealed from the qualitative interpretation of residual and second vertical derivative of gravity potential.

For the best model postulation, the following are considered :

- a. Geological boundaries, interfaces between different formations, average dips of different beds and fault planes with their relative displacements.,
- b. Formation densities have to be available with the value of $1.03 \times 10^3 \text{ kg m}^{-3}$ is taken for sea water density. The exploratory well Qusier B1x is taken as a reference considering that the basement is of gabbroic type (oceanic crust) of density $2.825 \times 10^3 \text{ kg m}^{-3}$.
- c. Bott and Smith (1958) proposed a formula for calculating the maximum depth of basement structure which is used as a guide in modelling postulation.

Two profiles, $C_3 D_3$ and $C_4 E_2$, running across the perpendicular to the predominant anomalies of the Bouguer and residual anomaly maps (Fig. 2 and 6) were selected. For each profile, a certain stratigraphic geological model was postulated, the coordinates of its corners were picked up and fed to the computer. The theoretical anomaly profile is computed several times for each model. Each time, different density contrasts, positions and shapes of stratigraphic bodies, are used.

Results and Discussion

Concerning the Bouguer Map

Referring to the composite log section (Fig. 4), inspection of the Bouguer map (Fig. 2) shows that :

- a. The study area is affected by given gravity belts, (AA' , BB' , DD' , and EE') of NW-SE trend parallel to the clysmic trend of the Red Sea. These belts comprise many local anomalies of elliptic shape.
- b. The area is dissected by a set of NW-SE trending faults, as indicated by the maximum gradient zones ($> 2.5 \text{ mgal/km}$) separating the gravity belts.
- c. The major negative belt AA' , is of about 12 mgal maximum relief and 190 km^2 . It could be recognized as a synclinal feature, bounded by two faults ($F_1 F_1$ and $F_2 F_2$) from its eastern and western sides, respectively.
- d. The positive belts DD' and BB' bound AA' from the east and west respectively. DD' covers an area of about 200 km^2 and comprises the highest relief (28 mgal) throughout the extreme NE and SE of the study area. BB' is about 12 mgal maximum relief and covers about 750 km^2 .
- e. The negative belt CC' lies to the west of BB' at the western border of the area and has a maximum relief of about 8 mgal and covers an area of about 680 km^2 . It is found that the two belts CC' and BB' are separated by a fault zone $F_3 F_3'$. Moreover, the general tendency, behaviour, and flowage of contour lines, defining the belt CC' may suggest the existence of another fault $F_4 F_4'$.
- f. The belt EE' lies at the eastern border of the map area. It is assumed that the two belts EE' and DD' are separated by the two faults $F_5 F_5'$ and $F_6 F_6'$ perpendicular to the Red Sea trend.
- g. The dominating fault system F_1 , F_2 , F_3 and F_4 suggest that the study area is structurally composed of successive horsts and grabens.
- h. The inferred fault zones F_5 and F_6 are assumed to be of shallows origin.

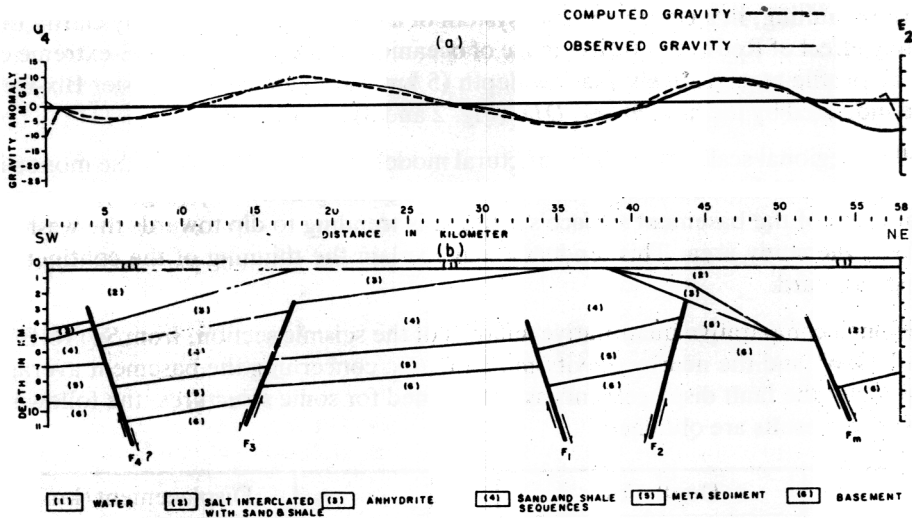


FIG. 10. Computed and observed gravity anomalies (a) along $C_4 E_2$ profile and the corresponding assumed structural model (b).

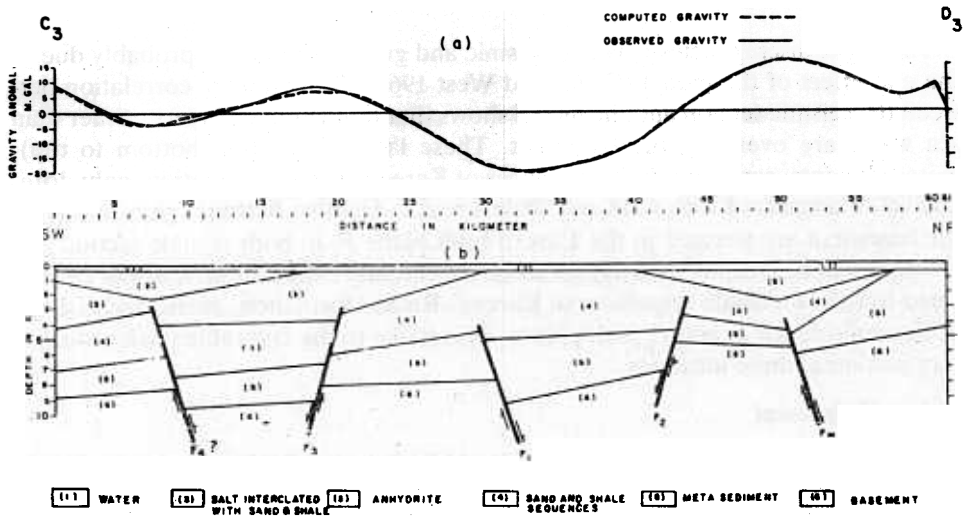


FIG. 11. Computed and observed gravity anomalies (a) along $C_3 D_3$ profile and the corresponding assumed structural model (b).

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